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**Children show selectively increased language imitation after experiencing ostracism**

Zoe Hopkins, Holly P. Branigan

**Research highlights**

- We tested whether ostracism modulates spontaneous language imitation in two samples of school-aged children.
- Children spontaneously imitated a partner's lexical choices and grammatical choices in a picture-matching game.
- Children who experienced ostracism were more likely to imitate a partner's word choices, but not their grammatical choices, than children who did not.
- Children's linguistic imitation is selectively influenced by social motivation in similar ways to their non-linguistic imitation.

## Abstract

When threatened with ostracism, children attempt to strengthen social relationships by engaging in affiliative behaviors such as imitation. We investigated whether an experience of ostracism influenced the extent to which children imitated a partner's language use. In two experiments, 7-12 year-old children either experienced ostracism or did not experience ostracism in a virtual ball-throwing game before playing a picture-matching game with a partner. We measured children's tendency to imitate, or align with, their partner's language choices during the picture-matching game. Children showed a strong tendency to spontaneously align with their partner's lexical and grammatical choices. Crucially, their likelihood of lexical alignment was modulated by whether they had experienced ostracism. We found no effect of ostracism on syntactic alignment. These findings offer the first demonstration that ostracism selectively influences children's language use. They highlight the role of social-affective factors in children's communicative development, and show that the link between ostracism and imitation is broadly based, and extends beyond motor behaviors to the domain of language.

**Key words: ostracism; affiliation; language imitation; alignment; conversation**

As humans, we have a fundamental need to belong (Baumeister & Leary, 1995), and we are correspondingly sensitive to threats to our inclusion in a group (Spoor & Williams, 2007; Wesselmann, Bagg, & Williams, 2009). For instance, when we experience ostracism – the act of being ignored or excluded – we can become motivated to affiliate, and display increased conformity, compliance, and obedience (Carter-Sowell, Chen, & Williams, 2008; Riva, Williams, Torstrick, & Montali, 2014). Such responses convey our similarity to others and so facilitate our reinclusion (Williams, 2007). In particular, there is a strong relationship between ostracism and behavioral imitation: After experiencing ostracism, adults are more likely to imitate a social partner's physical mannerisms (e.g., Lakin, Chartrand, & Arkin, 2008), and this imitation in turn effectively promotes liking and rapport (Chartrand & Bargh, 1999). Recent research has shown that children are also highly sensitive to ostracism from a young age (Crick, Casas, & Ku, 1999). Moreover, they show the same relationship between ostracism and imitation as adults: After experiencing ostracism, they imitate a partner's physical actions more accurately (Over & Carpenter, 2009b). But does this link between ostracism and imitation extend to their language use? In other words, do children imitate others' language as a response to ostracism and as a means to achieve affiliative goals? In this paper, we address this question by investigating whether 7-12-year-old children show an increased tendency to imitate a partner's choices of words and grammatical structures after experiencing ostracism.

Previous research has highlighted the risk factors and long-term repercussions of ostracism in childhood (e.g., Crick, Casas, & Mosher, 1997; Von Klitzing et al., 2014), and the immediate impacts of ostracism on both children's psychological wellbeing and their physical and cognitive functioning (e.g., Abrams et al., 2011; Barkley, Salvy, & Roemmich, 2012; Hawes et al., 2012; Zadro, Williams, & Richardson, 2004). However, few investigations have considered the immediate impact of ostracism on children's social behaviors, despite strong evidence that children show a bidirectional relationship between social perception and social behavior from early in development. For example, at eighteen months children help an adult

more often and more spontaneously after viewing photographs evoking affiliation than after photographs evoking individuality (Over & Carpenter, 2009a), and show increased helping when their actions have been imitated by an experimenter than when they have not, even beyond the immediate (mimicking) interaction (Carpenter, Uebel, & Tomasello, 2013).

Nevertheless, a growing body of research suggests that, like adults, children who have experienced ostracism display an increase in affiliative behaviors, compared with children who have experienced inclusion (the control condition). Some recent studies of pre-schoolers have experimentally manipulated ostracism and compared the behaviors of children exposed to ostracism with those of children not exposed to ostracism. After observing a video depicting third-party ostracism, 5-year-olds showed increased imitation of an experimenter's actions (Over & Carpenter, 2009b), and 3-6-year-olds displayed higher imitative fidelity when copying conventional (i.e., socially motivated) rather than instrumental actions (Watson-Jones, Legare, Whitehouse, & Clegg, 2014). In another study, 4-5-year-olds who observed third-party ostracism subsequently drew more affiliative pictures of themselves and a friend than those who did not (Song, Over, & Carpenter, 2015).

Children also show consistent behavioral effects after experiencing direct (first-hand) ostracism: 5-6-year-olds who played a virtual ball-throwing game in which they were ostracised by other players subsequently imitated a conventional action sequence more closely than those who were not ostracised, and this effect was stronger when they were ostracised by in-group rather than out-group members (Watson-Jones, Whitehouse, & Legare, 2016). Moreover, 5-year-olds who experienced arbitrary (rather than accidental) first-hand ostracism subsequently told stories that were more mentalistic, suggesting that being ostracised led children to deeper consideration of others' perspectives and mental states (White et al., 2016).

The dominant explanation proposed for these findings is based on goal activation theory (Aarts & Dijksterhuis, 2000). Under this account, social experiences – such as an

episode of experimentally-induced ostracism – directly activate affiliation goals, which in turn activate affiliative behaviors to accomplish those goals (Over & Carpenter, 2009b; although cf. Gardner, Pickett, & Brewer, 2000). So children who have experienced ostracism are confronted by affiliative goals, which then activate affiliative behaviors such as imitation that will induce rapport and liking. Accordingly, children who have been ostracised during a ball-throwing game will show an increased tendency to subsequently imitate a partner's actions, compared to children who have not been ostracised.

But to what other domains beyond motor actions might such affiliative behaviors extend? In particular, might children who have experienced ostracism also modify their language behaviors for affiliative reasons, for example by tending to imitate a partner's language in the same way that they imitate their motor behaviors? If imitative behaviors play a general role in promoting social relations, then a child who has been threatened by ostracism might imitate a partner's language use as a way of achieving her goal of ingratiating herself and reintegrating with the group. Critically, such a pattern would establish the broad basis of imitative behaviors as a means of encouraging social cohesion during development. Equally, it would support a role for social-affective influences on children's linguistic behaviour and communication, demonstrating that language serves a cohesive as well as communicative function during development (see Bannard, Klinger, & Tomasello, 2013). In turn, any such pattern would have implications for our understanding of the social and communicative challenges faced by children with impaired social-affective cognition, who might be unable to engage in a potentially valuable form of behavioral adaptation.

Surprisingly, however, it is not known whether children (or indeed adults) manifest sensitivity to ostracism via linguistic imitation, despite the key role that language plays in establishing and maintaining social relationships (e.g., Asher & Renshaw, 1981). Language imitation, or *linguistic alignment*, is a common feature of social interactions generally (Pickering & Garrod, 2004), and appears to play an important role in achieving both effective

communication and satisfying interactions (Fusaroli et al., 2012; Putman & Street, 1984). Such alignment occurs for many aspects of language during conversation. For example, if an adult refers to a *bunny* then her partner is more likely to subsequently refer to a *bunny*, even if *rabbit* would be his usual choice (Branigan, Pickering, Pearson, McLean, & Brown, 2011; Brennan & Clark, 1996; Garrod & Anderson, 1987). Adult interlocutors also imitate each others' choice of syntactic structure, for instance using a passive structure (e.g., *a queen is being kissed by a sheep*) more often after hearing their partner use a passive structure (e.g., *a robber is being chased by a dog*) than an active structure (e.g., *a dog is chasing a robber*; Branigan, Pickering, & Cleland, 2000; Messenger, Branigan, McLean, & Sorace, 2012).

Alignment effects are also robustly found in children's language use. Typically-developing pre-school- and school-aged children spontaneously align on the label that their partner has previously used to refer to an object and on a partner's choice of syntactic structure, even when those labels and structures are usually disfavored (Branigan, Tosi, & Gillespie-Smith, 2016; Garrod & Clark, 1993; Hopkins, Yuill, & Branigan, 2017; Huttenlocher, Vasilyeva, & Shimpi, 2004; Messenger, Branigan, McLean, & Sorace, 2012).

Explanations for linguistic alignment tend to appeal to one of three types of mechanisms. Within the psycholinguistic literature, most research has focused on communicative considerations of a conversational partner's knowledge and beliefs (*audience design*; Brennan & Clark, 1996) or automatic priming of linguistic representations (Pickering & Garrod, 2004). Audience design mechanisms make reference to beliefs about a partner's mental states that might affect their understanding of the message that the speaker intends to communicate. Thus a speaker might refer to a *bunny* after hearing her partner use that label because her partner's use leads her to believe that he understands and prefers that label, and that they have a mutual (implicit) agreement to use it. Priming mechanisms, in contrast, are impervious to beliefs, and depend upon the automatic activation and subsequent facilitation of linguistic representations during language use. For example, comprehending the word



*bunny* necessarily involves activating the relevant lexical representation, facilitating it for subsequent re-use.

In contrast, research within the social psychological literature has considered possible social-affective mechanisms for alignment, whereby speakers imitate a partner's language use as a means of achieving affiliative goals or expressing social identity (Giles & Powesland, 1975). These accounts build on the finding that listeners tend to prefer speakers who are similar to themselves (Smith, Brown, Strong, & Rencher, 1975). Accordingly, research has shown that speakers are more likely to align syntactically with those with whom they perceive themselves to be more similar (Weatherholtz, Campbell-Kibler, Jaeger, Hall, & Ave, 2014; see also Heyselaar, Hagoort, & Segaert, 2017; Hwang & Chun, 2018), and speakers who align with a partner's breadth of vocabulary and speech rate are rated more favorably than those who do not (Bradac, Mulac, & House, 1988; Putman & Street, 1984), and the positive affect induced by such linguistic imitation appears to yield tangible benefits for speakers (van Baaren, Holland, Steenaert, & van Knippenberg, 2003).

But although there is good evidence that adults imitate a partner's language use in ways that are modulated by social-affective factors, no studies have investigated whether ostracism might play a role in inducing linguistic imitation in the same way that it induces non-linguistic imitation, or – more generally – sought to directly link affiliative goals to linguistic behavior. A particularly powerful way to test whether ostracism affects linguistic behaviors in the same way that it affects non-linguistic behaviors would be to investigate whether the same manipulation of social inclusion/ostracism that has been shown to enhance non-linguistic imitation in previous studies also enhances linguistic imitation. If children who have experienced ostracism modify their linguistic behaviors in order to achieve affiliative goals, then they should show a stronger tendency to imitate a conversational partner's language choices than children who have not experienced ostracism.

However, it is possible that children might show socially-modulated linguistic alignment selectively for different aspects of language use. In particular, if children imitate a partner's linguistic behaviors for the same reasons that they imitate a partner's non-linguistic behaviors, then we might expect to find differences between their tendency to imitate syntactic versus lexical choices. Previous studies of children's non-linguistic imitation have shown that 'conventional' actions attract higher imitative fidelity than 'instrumental' actions, and moreover that this pattern is amplified by ostracism (Watson-Jones et al., 2014). Watson-Jones et al. suggested that this pattern occurs because imitation of 'conventional' actions serves to express social conformity, and as such promotes affiliation.

By the same token, syntax and lexis may correspond to a broad distinction between 'form' and 'meaning' in language. Thus children who have experienced ostracism might display high imitative fidelity for a partner's syntax (cf. Bandura & Harris, 1966), particularly when both forms of an utterance (e.g., 'a dog is biting a robber' vs. 'a robber is being bitten by a dog') felicitously convey the same denotational meaning (i.e., state of affairs), albeit potentially with slightly different emphases, and hence a partner's choice between the structures is opaque. In contrast, they might not show the same degree of imitative fidelity for a partner's lexical choices. Different names are normally associated with different denotational meanings (Clark, 1997), and young children in particular have strong beliefs about the appropriateness of specific names for specific objects (Matthews, Lieven, & Tomasello, 2010). Hence children might show more variability and innovation when choosing how to name the same object as their partner previously named.

To investigate whether ostracism leads children to modify their language behaviors, and specifically to imitate a partner's language use, we carried out two experiments in which 7-12-year-old children played a picture-matching game after experiencing ostracism, and compared their language use with children who had not experienced ostracism. We focused on school-aged children because this is an age at which they are beginning to form a variety of

social relationships but may also be at risk of ostracism (Abrams et al., 2011). In both experiments, we used a social manipulation that has been successfully used in many studies to induce experiences of ostracism and subsequent behavioral consequences in typically developing children of this age: the Cyberball paradigm (Williams et al., 2012), in which children play a ball-throwing game with virtual partners who exclude them (ostracism condition) or do not exclude them (control condition).

In our experiments, children played Cyberball with two virtual partners that they believed to be other children, and then played a version of the picture-matching game (based on the British children's game *Snap!*) with the experimenter. In the *lexical snap* version, each card depicted a single object, which players were invited to name as they played (although note that the descriptions were not critical to the game, as the game mechanics depended on a visual match between pictures that could be achieved without recourse to players' descriptions). Experimental objects had two possible names, one of which was strongly *favored* by children, and one of which was *disfavored*, as established by a pre-test (e.g., favored: *rabbit*; disfavored: *bunny*). In the *syntactic snap* version, each card depicted a transitive event that could be described with two structures, one of which was strongly favored (active; e.g., *a sheep is hitting a girl*) and one of which was strongly disfavored (passive; *a girl is being hit by a sheep*), as established in previous studies (e.g., Shimpi, Gámez, Huttenlocher, & Vasilyeva, 2007).

We manipulated the experimenter's descriptions of her cards (favored vs. disfavored name/structure), and measured children's lexical choices (Experiment 1) and syntactic choices (Experiment 2) when they subsequently described pictures that could be described using the same names or structures. Specifically, we investigated how likely children were to imitate, or align with, the experimenter's use of disfavored names/structures, and whether this tendency differed between children who had experienced ostracism and those who had not experienced ostracism. If children who had experienced ostracism were more likely than

controls to align (and conversely *less* likely to *misalign*), then this would provide novel evidence that children signal sensitivity to ostracism through their linguistic behaviors, and specifically that they do so through linguistic imitation of a social partner, in the same way as they do through non-linguistic imitation. If this tendency were stronger for syntactic alignment than for lexical alignment, it would indicate a finer-grained contiguity between children's socially-motivated linguistic imitation and socially-motivated non-linguistic imitation, where different aspects of a behavior are imitated to different extents depending on their specific function.

### Experiment 1 – Alignment of lexical choices

In Experiment 1, we investigated whether children spontaneously aligned lexical choices with a conversational partner, and whether any such tendency was modulated by having experienced ostracism.

## **METHOD**

### **Participants**

Participants were 58 typically-developing children (30 male; mean age [in years; months] = 8;11; age range = 7;1 – 10;8), predominantly White British, attending primary school in Dorset, UK. We tested an additional 10 children, but excluded their data on the basis of (1) a diagnosis of social/communication difficulties ( $N = 6$ ); (2) bilingualism ( $N = 2$ ); and (3) non-compliance with task instructions ( $N = 2$ ). Children were randomly assigned to one of two experimental conditions of Cyberball (ostracism vs. control [inclusion]). There were 29 children in each condition, who were well-matched in terms of chronological age, verbal ability (receptive and expressive vocabulary; assessed via the Kaufman Brief Intelligence Test – Second Edition; Kaufman & Kaufman, 2004), and gender (see Table 1).

Sample size determination was hampered by a lack of available data on affiliative language imitation, hence we aimed to test as many children as possible (and used Bayes factors to quantify the strength of evidence for the alternative versus null hypothesis; see coding and analysis section below).

## **Materials**

All children were administered the same battery of tasks in a fixed order, beginning with the Cyberball social manipulation (either ostracism or control condition), followed by the picture-matching game, then the language assessment, then a final game of Cyberball (inclusion trials only; see below). The order of tasks ensured that the picture-matching game always followed the Cyberball manipulation; we placed the language assessment at the end of the session to avoid participant fatigue before our key experimental measures.

### *Social manipulation*

We induced feelings of either ostracism or inclusion using Cyberball, a computerised ball-throwing game played with two other ‘players’ (actually pre-programmed software agents; Williams et al., 2012). We followed Zadro et al.’s (2013) guidelines in adapting the game for children. The School of Philosophy, Psychology & Language Sciences Research Ethics Committee (PPLSREC) at the University of Edinburgh approved the use of Cyberball in our study (title: ‘Conversational alignment in children with an Autism Spectrum Condition and typically developing children’; IRB protocol number: 207-1617/2).

We explained Cyberball to participants using an information screen (displayed on a laptop) that laid out a ‘cover story’ for the game. To deflect children’s attention from the purpose of the study, they were instructed to focus on using their imagination while playing the game, rather than on winning (Zadro et al., 2013). Children first played a warm-up round

of Cyberball (comprising six ball-throws [trials]) under the observation of the experimenter; this was to ensure that they understood the game, and were able to use the mouse to throw the ball to the other players. There were 20 trials (each lasting 200 milliseconds) in a full game session. In the ostracism condition, the ‘other players’ were programmed to throw the ball to the participant with equal probability across the first six trials; thereafter, they would throw the ball to only each other for the rest of the game. In the control condition, they were programmed to throw the ball to the participant with equal probability across all 20 trials.

On the game screen, players were represented by animated avatars (Figure 1). To heighten the authenticity of the Cyberball experience, each participant’s name appeared below their avatar; the avatars also appeared with names (matched for the participant’s gender) that were randomly drawn from lists of popular boys’ and girls’ names in England and Wales (Office for National Statistics, 2015). Experimental condition was blind-coded so that the experimenter was unaware of whether a child was assigned to the ostracism or control condition.

#### *Picture-matching game*

The lexical picture-matching game, including the experimental materials, was identical to Branigan et al. (2016). In the game, a child and the experimenter took turns turning over pictures, which they described, and deciding whether two adjacent pictures were identical. The 20 experimental items comprised pairs of picture cards (a *prime* and a *target card*) and a scripted *prime name* (favored vs. disfavored). The prime and target pictures depicted the same object. All experimental objects had two conventional names, one of which was strongly favored (e.g., *rabbit*) and one of which was strongly disfavored (e.g., *bunny*), as established by a pretest (see Branigan et al., 2016, for details of the pre-test).

We prepared two paired (experimenter/child) lists, each containing one version of each experimental item in a Latin Square design, so that each list contained ten items with

favorable prime names and ten items with disfavoured prime names, plus 28 filler pictures depicting objects with one conventional name (e.g., *cake*; see Figure 2a). Children were randomly assigned to lists; item order was individually randomized for each child with the constraint that two fillers intervened between the experimenter's prime card/prime name, and the child's associated target. Thus the lists were constructed so that the experimenter always described her prime card first, and after two filler cards (one described by the child and one described by the experimenter), the child described the target card.

### *Language measures*

We assessed children's vocabulary abilities via the verbal scale of the Kaufmann Brief Intelligence Test – Second Edition (KBIT-2; Kaufmann & Kaufman, 2004). The scale is composed of two parts: Verbal Knowledge and Riddles. The Verbal Knowledge subtest tests receptive vocabulary: The experimenter read words that children were asked to match to one of six pictures. The Riddles subtest tests expressive vocabulary: Children had to say a word that answered riddles spoken by the experimenter (e.g., *what is something shiny and hard that you wear on your finger?*). Hence the verbal scale yields a receptive and an expressive vocabulary score for each child; these are raw scores which are summed to yield a standardised measure of overall language ability.

### *Pre- and post-manipulation measures*

Before the practice round of Cyberball, we measured children's mood to verify that children's response to playing Cyberball reflected their condition assignment, rather than how they were feeling on the day (see Abrams et al., 2011). A post-manipulation check asked children how much they received the ball during the game, to establish that they were aware of their ostracised/included status.

Both the mood measure – ‘Today I feel good about myself’ (1 = not at all; 5 = very good) – and the post-manipulation check – ‘How much did they throw you the ball?’ (1 = not at all; 5 = a lot) – were presented on paper as five-point response scales (Abrams et al., 2011). Children recorded their responses on paper forms marked with an identifying number, which they posted into a ballot box so that the experimenter remained blind to the condition to which they had been assigned.

### **Procedure**

At the beginning of the experimental session, children were given a detailed overview of the tasks they would be asked to complete. This was in order to minimise delay between Cyberball and the picture-matching game, which might have limited the effectiveness of the social manipulation.

We first measured children’s mood. After children had read the cover story for Cyberball, and played a warm-up round, the experimenter checked that that they understood how to play the game, and were able to use the laptop. While children played the first game session, the experimenter positioned herself away from the laptop screen, to avoid seeing whether a child was experiencing inclusion or ostracism. After the game session had finished, children completed the post-manipulation check.

Children then played the picture-matching game with the experimenter. During the game, the experimenter and child each had a pile of face-down cards, and took turns revealing their top card, describing the picture on it, and laying it face-up on the table. The experimenter always went first, following a script that specified the appropriate description for each card, so that she named her prime card two turns before the child named the associated target card. Children were not instructed how to name the cards, but were allowed to name them freely. When adjacent cards were identical, the first player to say ‘snap!’ won those cards and any others placed down beforehand.



Children then completed the KBIT-2 subtests (Verbal Knowledge, then Riddles). Last, they played a final game of Cyberball in which they always experienced inclusion, to ensure that children left the session in a positive mood (e.g., Ruggieri et al., 2013). After data collection for the experiment had been completed, the researcher explained to children that the other Cyberball game players had not been real.

### **Coding and analysis**

Target responses were categorised as *Favored*, *Disfavored*, or *Other* (Table 2). Disfavored responses were coded as 1, and all other responses (favored/other) as 0. Seven target responses were excluded from analysis, owing to experimenter error ( $N = 1$ ) or children's non-adherence to game protocol ( $N = 6$ ).

There were three parts to our analysis. First, we used the pre-manipulation check scores to confirm that children in the different Cyberball conditions did not differ in terms of their mood on the day of testing and the post-manipulation check scores to confirm that the Cyberball manipulation had worked as intended.

Second, we analysed our picture-matching game data with logit mixed effect (LME) models, using the lme4 package (version 1.1-21; Bates et al., 2019) in R (version 3.6.1; R Core Team, 2019), to examine whether children spontaneously aligned on the disfavored names used by the experimenter during the picture-matching game, and whether children's alignment varied across the Cyberball conditions. LME models are appropriate for handling categorical dependent measures, and can account for unmeasured sources of heterogeneity in psycholinguistic data (e.g., from participants and experimental items; Barr, Levy, Scheepers & Tily, 2013). We constructed an LME model (our experimental model) in which the dependent variable was the likelihood of aligning with the experimenter on a disfavored name, which we predicted from the fixed effects (i.e., independent variables) of prime name (favored vs. disfavored) and condition (ostracism vs. control), and a prime name\*condition interaction

term. Crucially, the interaction term would indicate whether children's responses to the experimenter's prime names (i.e., their alignment) varied according to experimental condition. We also included children's raw receptive and expressive vocabulary scores as fixed effects, to test whether these aspects of verbal ability contributed to lexical alignment. The model incorporated by-item and by-participant random intercepts, as justified by the experimental design.

Third, we conducted follow-up tests on our experimental model. A simple effects analysis was performed on the prime name\*condition interaction using the *emmeans* package (version 1.2.3.; Lenth, 2018) in R. We used a likelihood ratio test to compare the experimental model against a null model that included only the fixed effect of prime name. This test generated parameter estimates that allowed us to evaluate the goodness-of-fit of our experimental model, and a *p*-value to assess the significance of the prime name\*condition interaction. We also used the models' Bayesian Information Criteria (BIC) values to estimate Bayes Factors, which offer an alternative to classical hypothesis testing. A key motivation for using Bayes Factors was that, owing to the lack of prior studies examining the influence of ostracism on children's language imitation, we were unable to use a traditional power analysis to determine a sample size for our experiment; power analyses depend upon published effect sizes to establish the threshold beneath which a hypothesis would be rendered false. Bayes Factors have been argued to be better than, for example, power calculations (Dienes, 2014), and the use of Bayes Factors allowed us to quantify the strength of evidence for the alternative hypothesis versus the null hypothesis.

## RESULTS

### *Pre- and post-manipulation check scores*

A Mann-Whitney test on children's responses to the statement 'Today I feel good about myself' (1 = not at all; 5 = very good) showed no significant difference between the ostracism

( $Mdn = 4$ ) and control ( $Mdn = 4$ ) conditions,  $U = 333.50$ ,  $p = .17$ . However, a second Mann-Whitney test on children's responses to the question 'How much did they throw you the ball?' (1 = not at all; 5 = a lot) showed a significant difference between the ostracism and control conditions,  $U = 79.0$ ,  $p < .001$ ; children in the ostracism condition reported receiving the ball less frequently ( $Mdn = 2$ ) than children in the control condition ( $Mdn = 4$ ). This effect suggests that the social manipulation was effective.

#### *LME model for lexical picture-matching game data*

The experimental LME model is reported in Table 3. The model revealed a significant effect of prime name, indicating that children showed lexical alignment: They produced a higher proportion of disfavored target responses after hearing the experimenter use a disfavored prime name than after hearing the experimenter use a favored prime name (62% vs. 5% disfavored responses, as a % of total favored+disfavored responses). Children's overall likelihood of producing a disfavored name was not significantly related to their receptive or expressive vocabulary abilities.

Critically, the experimental LME model revealed a significant interaction between prime name and condition, suggesting that the extent to which children aligned lexical choice with the experimenter varied according to whether or not they had experienced ostracism during the Cyberball game (Table 3; Figure 3a).

#### *Follow-up tests*

The simple effects analysis of the prime name\*condition interaction entailed a series of pairwise comparisons, to which we applied a Bonferroni correction. Only two of these comparisons were theoretically relevant to our experiment: One compared the likelihood of producing a *disfavored* name after hearing a *disfavored* prime in the ostracism vs. control condition (i.e., how likely children were to align lexical choice with the experimenter,

depending on whether or not they had experienced ostracism; e.g., prime: *bunny*/target: *bunny*); the other compared the likelihood of producing a *disfavored* name after hearing a *favored* prime in the ostracism vs. control condition (i.e., how likely children were to *misalign* lexical choice with the experimenter, depending on whether or not they had experienced ostracism; e.g., prime: *rabbit*/target: *bunny*);).

Children in the ostracism condition were significantly more likely than children in the control condition to produce disfavored names following disfavored primes (69% vs. 55%),  $z = -2.88, p = .004$ . Moreover, children in the ostracism condition were significantly *less* likely than children in the control condition to produce a disfavored name following a favored prime (3% vs. 7%),  $z = 2.62, p = .01$ . Taken together, these findings indicate that children's use of disfavored names more closely imitated the experimenter's use of disfavored names in the ostracism condition than in the control condition.

Parameter estimates from the likelihood ratio test showed that the prime name\*condition interaction contributed significantly to our experimental LME model fit,  $\chi^2(2) = 17.65, p < .001$ , supporting the hypothesis that children show stronger lexical alignment with an interlocutor when they have experienced ostracism than when they have not experienced ostracism. To assess the strength of this evidence, we estimated a Bayes Factor (BF10) as  $e^{(BIC_{null} - BIC_{experimental})/2}$  from the Bayesian Information Criterion (BIC) values of both the experimental and null models (Wagenmakers, 2007). The experimental model fit the data better than the null model,  $BF10 = e^{(972.72 - 969.16)/2} = 5.91$ , providing positive evidence that condition influenced the extent of children's alignment, according to Raftery's (1995) categorization.

## DISCUSSION

Children showed a robust tendency to repeat the disfavored name that their partner had previously used when they subsequently named the same object. Such lexical alignment was

spontaneous, and unrelated to children's receptive and expressive vocabulary abilities.

Crucially, although children in both groups showed a tendency to lexically align, the extent of this alignment varied according to whether or not they had experienced ostracism during the initial social manipulation. Children who had experienced ostracism were more likely than children who had not experienced ostracism to re-use a partner's choice of name.

These results show that the social effects that have been reported in studies of children's non-linguistic imitation and that have been linked to affiliative motivations (Over & Carpenter, 2013) extend to at least one aspect of their linguistic imitation. Additionally, the pattern of effects - whereby children in the ostracism condition were *more* likely than children in the control condition to produce disfavored names after a *disfavored* prime, but *less* likely to produce disfavored names after a *favored* prime - shows that they imitated word choices in a highly localised way, based on individual episodes of language use.

### Experiment 2 – Syntactic alignment

Experiment 1 established that school-aged children's tendency to spontaneously imitate a partner's lexical choices in a picture-matching game was influenced by a prior experience of ostracism. In Experiment 2, we investigated whether the same pattern would occur for syntactic choices, in other words whether children's tendency to spontaneously imitate a partner's use of a (disfavored) passive structure would be influenced by ostracism.

## **METHOD**

### **Participants**

Participants were 57 further typically-developing children (27 male; mean age [in years; months] = 9;6; age range = 8;0 – 12;10), predominantly White British, attending primary school in Edinburgh, UK. 27 children were randomly assigned to the inclusion condition of Cyberball, and 30 to the ostracism condition. The groups were well-matched by chronological

age, verbal ability (receptive grammar; assessed via the Test of Receptive Grammar – Second Edition; Bishop, 2004), and gender (Table 1). Sample size was determined as in Experiment 1.

### **Materials and procedure**

Children were administered tasks in the same fixed order as in Experiment 1, and following the same procedure: Cyberball social manipulation (either ostracism or control condition), followed by the picture-matching game, then the language assessment, then a final game of Cyberball (inclusion trials only). The social manipulation (Cyberball) was identical to Experiment 1, but the materials for the picture-matching game, and the language assessment were different.

#### *Picture-matching game*

The syntactic picture-matching game was adapted from Experiment 1 of Messenger et al.'s (2012) study. There were 24 experimental items, each comprising a prime and a target card, and an associated active and passive prime description in the present progressive form (e.g., *A sheep is hitting a girl; A girl is being hit by a sheep*). All cards depicted a transitive event involving an animal agent and human patient, but target cards displayed different agent-patient events and different characters to those on the relevant prime card (e.g., a tiger scratching a king). Eight 'snap!' items involving consecutive identical pictures were evenly distributed through the game. We prepared two paired (experimenter/child) lists, each containing one version of each experimental item in a Latin Square design, so that each list contained twelve items with an active description and twelve items with a passive description. Children were randomly assigned to lists; item order was individually randomized for each child. The syntactic picture-matching game followed the protocol used in Experiment 1, except that prime cards immediately preceded target cards (see Figure 2b).

*Language measure*

We assessed children's grammatical abilities using the Test of Receptive Grammar – Second Edition (TROG-2; Bishop, 2004). Children heard sentences read by the experimenter and had to match each sentence to one of four pictures.

**Coding and analysis**

Target responses were scored, following Messenger et al. (2012), as *Active* if it was a complete sentence that contained a subject bearing the agent role, a verb, a direct object bearing the patient role, and that could also be expressed as a passive; *Passive* if it was a complete sentence that contained a subject bearing the patient role, an auxiliary verb, a main verb, a preposition *by*, an object bearing the patient role, and that could also be expressed as an active; or *Other* (any other response; Table 2). Passive (disfavored) responses were coded as 1, and all other responses (active/other) as 0. Two target responses were excluded owing to experimenter error. We adopted the same approach to data analysis as in Experiment 1.

*Pre- and post-manipulation check scores*

There was no significant difference in children's mood between the ostracism ( $Mdn = 4$ ) and control ( $Mdn = 4$ ) conditions, Mann-Whitney  $U = 381.0$ ,  $p = .65$ . Children in the ostracism condition reported receiving the ball significantly less ( $Mdn = 2$ ) than children in the control condition ( $Mdn = 4$ ) during Cyberball, Mann-Whitney  $U = 158.50$ ,  $p < .001$ , suggesting that the social manipulation was effective.

*LME model for picture-matching game data*

Our experimental LME model (Table 3) predicted children's likelihood of aligning with the experimenter on a passive structure from the fixed effects of prime structure (active vs. passive), condition (inclusion vs. ostracism), and a prime structure\*condition interaction

term. Raw TROG-2 scores were also included as a fixed effect, to determine whether children's receptive grammar related to their syntactic alignment, along with by-item and by-participant random intercepts.

There was a significant effect of prime structure (Table 3), showing that overall, children syntactically aligned with the experimenter: Children produced a higher proportion of passive targets after hearing a passive prime than after hearing an active prime (29% vs. 8% as a % of all active/passive responses). Children's overall likelihood of producing a passive structure was not significantly related to their receptive grammar ability. Critically, the prime structure\*condition interaction term was not significant, indicating that the tendency to align did not vary according to whether children had experienced ostracism or had not experienced ostracism (Figure 3b).

#### *Follow-up tests*

Because the prime structure\*condition interaction was not significant, we did not submit this to a simple effects analysis. Goodness-of-fit calculations indicated that our experimental LME model was a poorer fit for our data than a null model including only the fixed effect of prime,  $\chi^2(2) = 0.20, p = .90$ . Bayesian analyses indicated that the experimental model was a poorer fit than the null model by  $BF_{10} = e^{(1068.80 - 1083.04)/2} = .001$ , which is very strong evidence *against* the hypothesis that ostracism influences children's syntactic alignment (Raftery, 1995).

## **DISCUSSION**

Children showed a robust tendency to spontaneously repeat the disfavored syntactic structure that their partner had used on an immediately previous turn when subsequently describing an unrelated event involving different lexical items. This alignment on abstract syntactic structure was unrelated to children's receptive grammar abilities. Unlike in Experiment 1, the magnitude of alignment did not vary according to whether children had



experienced ostracism during the initial social manipulation, despite children showing awareness of having been ostracised or not.

## GENERAL DISCUSSION

People are driven by a strong need to belong. When faced with the threat of ostracism, they modify their social behavior in order to promote and facilitate their inclusion within the group. We investigated whether this behavioral modification extends to the domain of language in school-aged children. In two experiments, we manipulated children's inclusionary status, and measured the extent to which they subsequently imitated, or aligned with, a partner on functional (lexical) and formal (syntactic) aspects of language in a picture-matching game.

Experiment 1 showed that children tended to spontaneously align with a conversational partner's lexical choices during a picture-matching game. However, this tendency was enhanced in children who had previously experienced ostracism compared to children who had not experienced ostracism: Ostracised children were more likely to describe target objects using a name that was normally disfavored after hearing the experimenter use the disfavored name to describe the same object. And they were conversely less likely to produce a disfavored name after hearing the experimenter use the favored name. Together, this pattern suggests that they adhered more closely to the experimenter's language choices overall than children who had not experienced ostracism. Experiment 2 showed that children also tended to spontaneously align with a partner's syntactic choices. But in contrast to Experiment 1, this tendency did not differ between children who had experienced ostracism and those who had not.

Our results demonstrate that children have a strong tendency to spontaneously imitate different aspects of a conversational partner's language use. But more importantly, they provide the first evidence (to our knowledge) of social-affective influences on children's

language behavior. In particular, they show that experiencing ostracism selectively modulates children's tendency to imitate a partner's language. Previous research has shown a relationship between affiliative goals and social behavior, and specifically between experiences of ostracism and enhanced non-linguistic imitation (Over & Carpenter, 2009b; Watson-Jones et al., 2014, 2016). Our findings are novel in extending this relationship to the domain of language. Thus our results suggest that the relationship between ostracism and imitation is not limited to motor behaviors, but rather has a broad basis across a range of behaviors. As such, they highlight the fundamental role that imitation plays in promoting social relationships (Lakin, Jefferis, Cheng, & Chartrand, 2003). Equally, they emphasise that language subserves not only communicative but also cohesive functions.

Our findings are also informative about the nature of the relationship between ostracism and linguistic imitation. First, they suggest that experiences of ostracism lead to a general (i.e., non-directed) enhancement in linguistic imitation, in the same way as in non-linguistic imitation. Participants in Experiment 1 showed a stronger tendency to repeat the experimenter's lexical choices after being ostracised by (what they believed to be) two other children. Here, as in Watson-Jones et al.'s (2016) study of non-linguistic imitation, the target of imitation (and hence the target with whom affiliation was sought) was not the source of the exclusionary threat. From this we can infer that ostracism causes an increase in affiliative linguistic behaviors generally, rather than an increase directed specifically at the ostracising agent. In other words, being ostracised leads children to imitate others' language in order to promote re-inclusion with *a* group, but not necessarily *the same* group.

In another respect, however, the results of Experiment 1 suggest that children's social-affective linguistic imitation is closely targeted: Children in the ostracism condition were more likely than children in the control condition to produce disfavored names after hearing a disfavored prime (e.g., prime: *bunny*/target: *bunny*) - but they were also *less* likely to produce disfavored names after hearing a *favoured* prime (e.g., prime *rabbit*/ target: *bunny*). Hence they

did not show a greater likelihood of producing disfavored names overall. Instead their heightened sensitivity to the experimenter's linguistic behavior was tied to individual episodes of language use in the picture-matching game, i.e., the specific lexical choice that their partner made for a specific object.

As such, our findings do not provide evidence for the 'communication accommodation' that has sometimes been observed in adult dialogue, which can involve adjusting one's linguistic *style* for a partner, with affective consequences (Giles & Powesland, 1975). For instance, Bradac et al. (1988) found that speakers who converged in their overall breadth of vocabulary were evaluated more favourably than those who did not. But such stylistic imitation would have led ostracised children to be more likely to produce disfavored names in general (to reflect the experimenter's high overall rate of usage of disfavored names), rather than producing disfavored names only for objects for which the experimenter had used a disfavored name. We cannot rule out the possibility that children might imitate a partner's overall style (rather than specific episodes of language use) in some contexts. It may also be that the ability to co-ordinate stylistically in conversation involves more sophisticated linguistic and social-affective skills than school-aged children possess. But what is clear is that in our study, children imitated lexical choices for socially-motivated reasons in a highly localized way (Garrod & Doherty, 1994).

Importantly, however, our experiments suggest that the social modulation of linguistic imitation in children is selective: It does not occur across the board. The same social manipulation and the same interactional context yielded a reliable modulation of imitation for one aspect of language (lexical choices), but not for another (syntactic choices). The existence of an asymmetric pattern is not in itself surprising, but the direction of this asymmetry is unexpected. Existing evidence from adult dialogue has shown that social perception influences syntactic alignment (Balcetis & Dale, 2005; Heyselaar, Hagoort, & Segaert, 2017; Hwang & Chun, 2018; Weatherholtz, Campbell-Kibler, Jaeger, Hall, & Ave, 2014). Moreover,

previous research on ostracism and non-linguistic imitation has found graded patterns of effects, with children manifesting sensitivity to ostracism to a greater extent when imitating conventional actions, in which the realization of the action is arbitrary and so imitation necessarily indicates conformity to a group, than when imitating functional actions (Watson-Jones et al., 2014).

Hence there are good reasons *a priori* to expect that children might manifest sensitivity to ostracism in their syntactic choices, and furthermore that this sensitivity might be manifested more strongly in their syntactic choices, which may more strongly reflect choices about form than about meaning (e.g., different syntactic structures, such as the active and passive versions of a sentence, can convey the same denotational meaning) than in their lexical choices, which may primarily reflect choices about meaning (e.g., different words convey different meanings). Yet in our study, children not only manifested less sensitivity to ostracism in their syntactic choices than in their lexical choices, they manifested no detectable sensitivity whatsoever.

What might underlie this unexpected pattern of effects? One possibility is that the social manipulation was ineffective in Experiment 2, i.e., children in the ostracism condition did not in fact experience ostracism, and hence showed no effect of the manipulation. But the results of our manipulation check suggest that the manipulation was effective: Children in the ostracism condition appropriately reported receiving the ball significantly less than children in the control condition. Another possibility is that the basic syntactic alignment effect was too weak or too strong to admit modulation. But the magnitude of alignment (21% more disfavored passive responses after passive primes than after active primes) suggests that responses were neither at ceiling nor at floor, and hence allowed for significant modulation to occur.

It therefore appears that experiencing ostracism indeed impacted children's linguistic behavior differently with respect to their lexical choices versus their syntactic choices. We

now consider three possible interpretations of these results, but note that they need not be mutually exclusive. The first possibility relates to the nature of lexical versus syntactic choices in language use, both generally and also in the specific context of our experiments. We suggest that lexical choices may be a particular locus for affiliative behaviors because they are a strong cue about individual speaker's preferences, and particularly so within our experimental design. Lexical choices are a strongly pragmatically conditioned aspect of language: Clark (1997) argued that when a partner uses a particular name for an object, she indicates not only that she understands that name but also prefers it (and its associated conceptualization) to alternatives. Previous evidence shows that the existence of shared preferences promotes a sense of interpersonal similarity (Gershman, Pouncy, & Gweon, 2017). Thus by conveying her stable preferences, the experimenter's lexical choices may have been particularly effective in eliciting affiliative behaviors (in this case, imitation). Note that this interpretation is closely related to research on adults' alignment on referential expressions that accounts for such effects in terms of local conventions or 'conceptual pacts', whereby interlocutors tacitly agree to adhere to one partner's expressed preference (Brennan & Clark, 1996).

In contrast, although syntactic contrasts also index a speaker's meaning and preferences (Clark, 1987), they may do so less saliently than lexical contrasts (Branigan, Pickering, Pearson, & McLean, 2010), especially among inexperienced language users. This would have been particularly the case in our experiments. In Experiment 1, the experimenter always named each object once (and thus expressed a clear preference with respect to the appropriate lexical choice). But in Experiment 2, the experimenter used both active and passive structures equally frequently through the experiment as a whole. Thus although she expressed a preference regarding the appropriate syntactic choice for any given picture (and note that the child always described different pictures to the experimenter), her behavior did not express an overall preference for one structure or the other. It is possible that in a context

where a partner more consistently expressed a preference for one structure over another, children who had experienced ostracism and so sought affiliation would show an enhanced tendency to imitate syntax.

A different possibility is that our findings reflect a discrepancy in processing demands between the lexical and the syntactic picture-matching games, which served to either strengthen or weaken the impact of our affiliation manipulation on children's alignment. If the effect of our ostracism manipulation was transient, it is possible that it exerted a stronger influence in the lexical picture-matching game, where children were required to comprehend and produce simple, single words, than in the syntactic picture-matching game, where children had to comprehend and produce complex sentences. Shatz (1983) proposed that children's conversational behavior fluctuates according to task demands. Accordingly, the syntactic picture-matching game may have been sufficiently demanding of children's cognitive capacity to hinder any social-affective adaptation of their linguistic behaviour. Certainly, there is evidence that speakers are able to engage more effectively in communicative perspective-taking when they have adequate time and cognitive resources (Epley, Morewedge, & Keysar, 2004; Nadig & Sedivy, 2002; Nilsen & Graham, 2009). We do not claim that increased alignment is a conscious response to ostracism (Lakin & Chartrand, 2003; Lakin et al., 2008), but it is possible that the greater cognitive demands of conceptualising and producing sentential descriptions (including more complex passive structures) in Experiment 2 may have extinguished the effects of experiencing ostracism.

A third interpretation is that the effects of ostracism that we observed in children's lexical alignment reflect cue-dependencies. In the lexical picture-matching task, children had the opportunity to imitate from the same exemplar modelled by the experimenter, since all primes and their associated target cards shared a conspicuous common token (e.g., the same brown, short-haired rabbit). In this regard, the lexical picture-matching game was more analogous than the syntactic picture-matching game to the tasks described in the non-

linguistic imitation literature. For instance, in Over and Carpenter's (2009b) study, an experimenter chose a tool to perform an action sequence that opened a box; after watching this demonstration, children received the same tools and box and were asked to open the box themselves. Although in both experiments our picture-matching game involved spontaneous imitation – like the tasks used in non-linguistic imitation studies – the lexical game may have more clearly cued children's imitation than the syntactic game, in which prime and target cards did not overlap in terms of the events and agents/patients depicted. If affiliative motivations promote increased encoding and recall of demonstrated actions, as the 'social hunger' account proposes (Gardner et al., 2000), then these cues might have been particularly salient for children who had experienced ostracism. We note however that previous evidence found children's lexical alignment is unaffected by whether prime and target cards depict the same or different tokens, suggesting that such cues play a minimal role in lexical alignment in contexts that do not involve explicit social manipulations (Branigan et al., 2016).

Our study does not determine the mechanisms by which ostracism led to children's increased lexical alignment. Previous work has identified a social-affective component to linguistic imitation (Bradac et al., 1988; van Baaren et al., 2003), but did not consider such effects in the context of ostracism. Studies of non-linguistic imitation have attributed social-affective effects to affiliation goals, which are triggered directly and automatically by an experience of ostracism (Aarts & Dijksterhuis, 2000). If we apply this account to Experiment 1, then an experience of ostracism activated affiliation goals that in turn induced children to imitate the experimenter's lexical choices with greater frequency than controls. By conveying their similarity to a social partner in this way, children could facilitate their social (re)inclusion, since people respond prosocially to being mimicked (Chartrand & Bargh, 1999; Carpenter et al., 2013).

Alternatively, an experience of ostracism may have altered how children in Experiment 1 processed incoming social information: Under a social hunger account (Gardner et al.,

2000), the affiliation manipulation would have influenced how much attention children gave to the experimenter's lexical choices, and conferred a selective memory advantage for disfavored words on the children who experienced ostracism. Similar ideas have been integrated with language processing models to explain socially-mediated effects on syntactic alignment in adults (Hwang & Chun, 2018), and we have also suggested that enhanced coding might have occurred at the level of the tokens depicted on the Snap! cards.

One way of distinguishing between the affiliative goals and social hunger accounts as they apply to lexical alignment would be to have children play the picture-matching game, and then to rename the experimental items after an interval in a non-social context (e.g., as part of a single-player computerized game). If enhanced encoding were the mechanism that induced affiliative motivation and hence increased alignment during the game, then ostracised children should continue to show an advantage over control children for disfavored names even in a non-social context; whereas an affiliative goals account would predict that the advantage for ostracised children would be attenuated in a non-social context.

We note that both accounts would predict that any manipulation that induced affiliative goals (i.e., not just experiences of ostracism) would yield similar effects. However, this remains to be established in future work. More generally, it is unclear how far effects of social modulation on language imitation might extend. Our results already suggest that they are restricted in at least some ways (i.e., with respect to imitation of syntactic choices in these experiments). But we cannot determine to what extent such effects might be contingent on the context of language use. Our experiments involved a two-player picture-matching game in which children sought to win cards. Although the game involved competition (as players competed with each other to win cards), it also necessarily involved cooperation (as players were engaged in joint action that involved a mutual goal to play the game, mutual adherence to its rules, appropriate turn-taking etc.). It therefore seems likely that the context in which language imitation occurred was one that intrinsically promoted affiliation, and hence may



have attenuated the effects of our social manipulation. Other contexts that did not similarly promote affiliation might show a stronger modulation in language imitation as a function of a social manipulation.

Relatedly, it is unclear to what extent similar modulations might be contingent on the experience of ostracism versus inclusion, or ostracism in and of itself. In these experiments, we followed previous research in comparing children's (linguistic) behaviors after experiencing ostracism in a game with a control condition in which children not only failed to experience ostracism, but in fact actively experienced inclusion (i.e., they received the ball the same number of times as other players; e.g., Watson-Jones et al., 2016; White et al., 2016; Abrams et al., 2011). This comparison might in principle exaggerate the effects of the ostracism manipulation. However, recent research using the Cyberball paradigm suggests that more neutral control conditions provide a similar experience to inclusion (Dvir, Kelly, & Williams, 2018), suggesting that the results found here are likely indicative of children's response to ostracism as such.

Finally, our study focused on school-aged children. Although sensitivity to ostracism is manifested across the lifespan, from early childhood (e.g., Over & Carpenter, 2009b; Watson-Jones et al., 2016) to old age (e.g., Hawkley, Williams, & Cacioppo, 2011), recent research suggests that responses vary with age (Abrams et al., 2011), and may be particularly strong during adolescence (Tang, Lahat, Crowley, Wu, & Schmidt, 2019). We might therefore expect to find the same qualitative pattern across the lifespan of enhanced lexical after experiencing ostracism, but that there would be quantitative differences in the magnitude of these effects. One possibility is that such alignment would be enhanced in adolescence, and might indeed be supplemented by sensitivity to other aspects of language behavior (e.g., syntactic choice). An alternative possibility is that people develop a more sophisticated and comprehensive repertoire of affiliative behaviors with increasing age, so that language imitation as a means of promoting social relationships may come to be manifested differently (e.g., through broader

stylistic accommodation) during adolescence and adulthood than in the age range studied here. Importantly, there is a considerable body of research suggesting that convergence with a partner's language continues to play an important social-affective role in adulthood (Giles, Coupland, & Coupland, 1991).

In sum, the present study makes an important contribution to our understanding of social imitation, by providing novel evidence that the relationship between ostracism and motoric imitation in children extends to children's imitation of language. Children who experienced ostracism showed a stronger tendency to imitate the lexical choices of a partner, implicating linguistic behavior (and specifically lexical alignment) as an additional behavior through which children might address threats to their sense of belonging. This finding underlines the role of social-affective factors in children's communicative development. But it also suggests that a potentially valuable form of behavioral adaptation might be unavailable to children who have impaired social-affective understanding (though see Branigan et al., 2016; Hopkins et al., 2017). Our findings also highlight contiguities between children's motoric and language imitation, and provide an intriguing lead for new research in a field where cross-domain relationships in imitative behavior are underexplored. As such, they highlight the need for further investigations of the range and conditions of children's affiliative behavior, the outcomes of which are likely to have profound implications for theories of child development.

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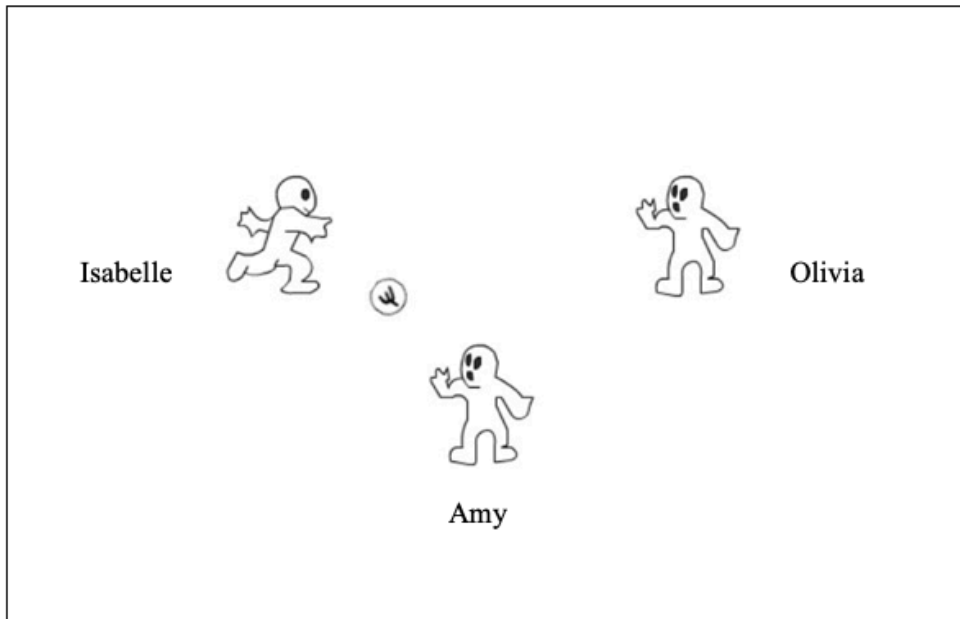
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Table 1: Participant characteristics (ages in years;months)

		Experimental group		
Experiment		Ostracism	Control	<i>p</i> value
1	Chronological age	<i>M</i> = 8;9 (range 7;1 – 10;8)	<i>M</i> = 9;0 (range 7;3 – 10;6)	.27 <sup>3</sup>
	Receptive vocabulary <sup>1</sup>	<i>M</i> = 28.79 ( <i>SD</i> = 5.84)	<i>M</i> = 27.83 ( <i>SD</i> = 5.15)	.51 <sup>3</sup>
	Expressive vocabulary <sup>1</sup>	<i>M</i> = 24.79 ( <i>SD</i> = 5.46)	<i>M</i> = 25.10 ( <i>SD</i> = 5.51)	.83 <sup>3</sup>
	Standardised vocabulary score <sup>2</sup>	<i>M</i> = 107.55 ( <i>SD</i> = 13.53)	<i>M</i> = 103.10 ( <i>SD</i> = 11.40)	.18 <sup>3</sup>
	Gender (M:F)	13:16	17:12	.29 <sup>4</sup>
2	Chronological age	<i>M</i> = 9;9 (range 8;4 – 12;10)	<i>M</i> = 9;6 (range 8;0 – 11;6)	.44 <sup>3</sup>
	Receptive grammar <sup>1</sup>	<i>M</i> = 14.60 ( <i>SD</i> = 3.70)	<i>M</i> = 14.63 ( <i>SD</i> = 2.91)	.97 <sup>3</sup>
	Standardised grammar score	<i>M</i> = 95.23 ( <i>SD</i> = 15.19)	<i>M</i> = 95.26 ( <i>SD</i> = 12.52)	.99 <sup>3</sup>
	Gender (M:F)	16:14	11:16	.34 <sup>4</sup>

<sup>1</sup> Raw scores<sup>2</sup> Standardised sum of receptive and expressive vocabulary scores<sup>3</sup> No significant group difference on an independent *t*-test<sup>4</sup> No significant group difference on a Chi-square test

*Figure 1: Screenshot of Cyberball game*



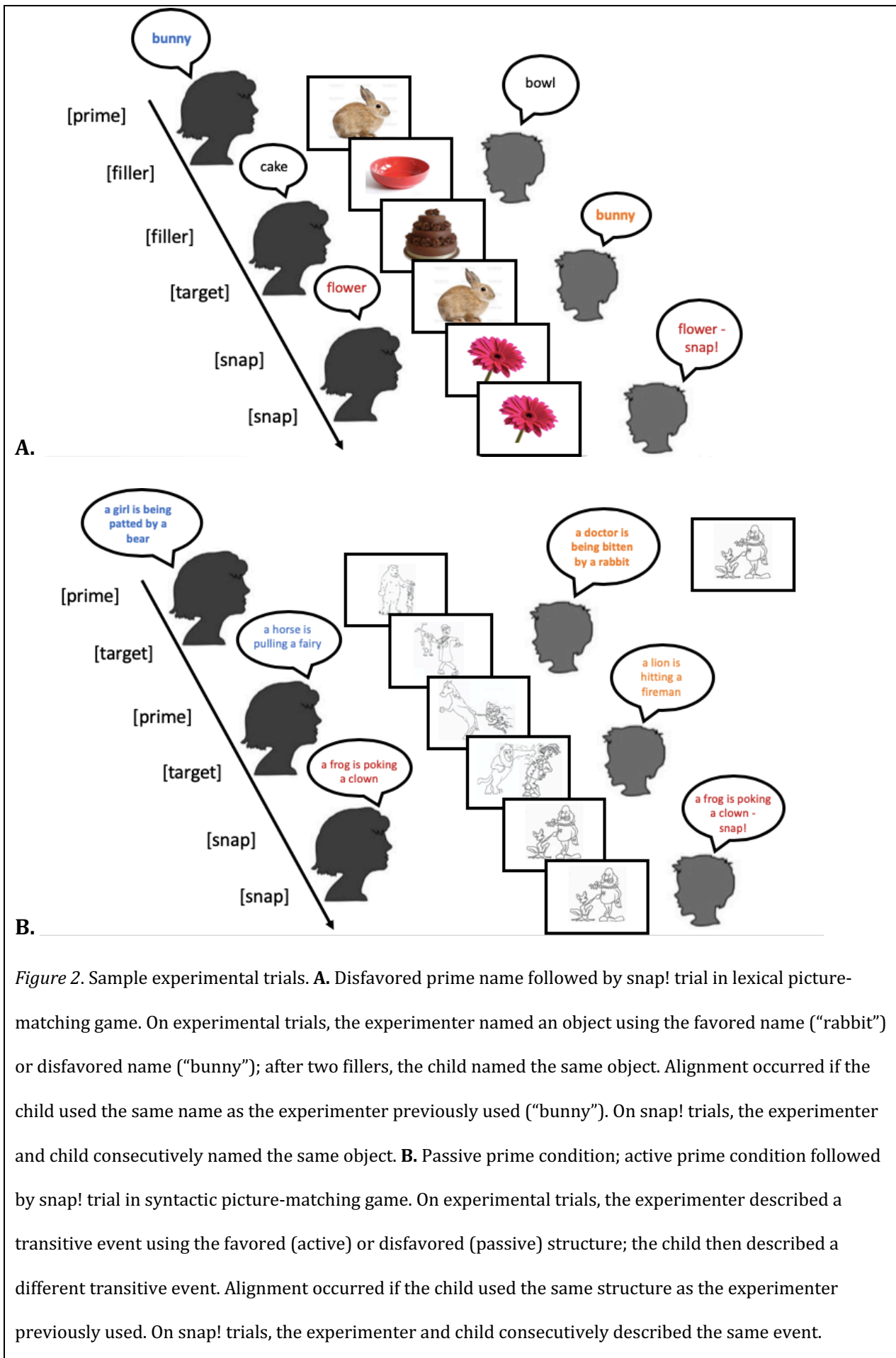


Table 2: Frequency (and %) of children's target responses, by prime and condition

Experiment	Condition	Response	Prime		Alignment effect <sup>†</sup> (95% bootstrapped CIs)
			Favored	Disfavored	
1	Ostracism	Favored	268 (92%)	83 (29%)	
		Disfavored	11 (3%)	197 (69%)	66% (60-72)
		Other	10	7	
	Control	Favored	254 (88%)	112 (39%)	
		Disfavored	22 (7%)	160 (55%)	48% (40-57)
		Other	12	17	
2	Ostracism	Active	319 (89%)	249 (69%)	
		Passive	25 (7%)	99 (27%)	20% (13-26)
		Other	14	12	
	Control	Active	282 (87%)	210 (65%)	
		Passive	27 (8%)	98 (30%)	22% (14-31)
		Other	15	15	

<sup>†</sup> Alignment effects represent percentage point increases in the observed probability of producing a disfavored response after a Favored vs. after a Disfavored prime name/structure.

*Table 3: summary of experimental LME models, predicting lexical<sup>1</sup> and syntactic alignment*

		Parameter estimates		Wald's test	
Experiment	Fixed effects	$\beta$	S.E.	Z	$p(\beta=0)$
1	Intercept	-1.50	0.21	-7.02	
	Prime name <sup>2</sup>	-4.09	0.28	-14.64	< .001
	Condition <sup>2</sup>	0.35	0.27	1.30	.20
	Receptive vocabulary <sup>3</sup>	0.19	0.12	1.67	.10
	Expressive vocabulary <sup>3</sup>	-0.13	0.11	-1.18	.24
	Prime name*condition	1.86	0.52	3.60	< .001
2	Intercept	-2.53	0.32	-7.92	
	Prime structure <sup>2</sup>	-2.49	0.42	-5.86	< .001
	Condition <sup>2</sup>	.03	0.49	.05	.95
	Receptive grammar <sup>3</sup>	0.24	0.22	1.06	.29
	Prime name*condition	-0.17	0.46	-0.37	.72

<sup>1</sup> Model converged upon simplifying random effects structure.

<sup>2</sup> Prime name, prime structure, and condition were deviation-contrast coded, with values -.5/.5 for levels Disfavored/Favored, and ostracism/control.

<sup>3</sup> Receptive vocabulary, expressive vocabulary, and receptive grammar were centered and scaled.

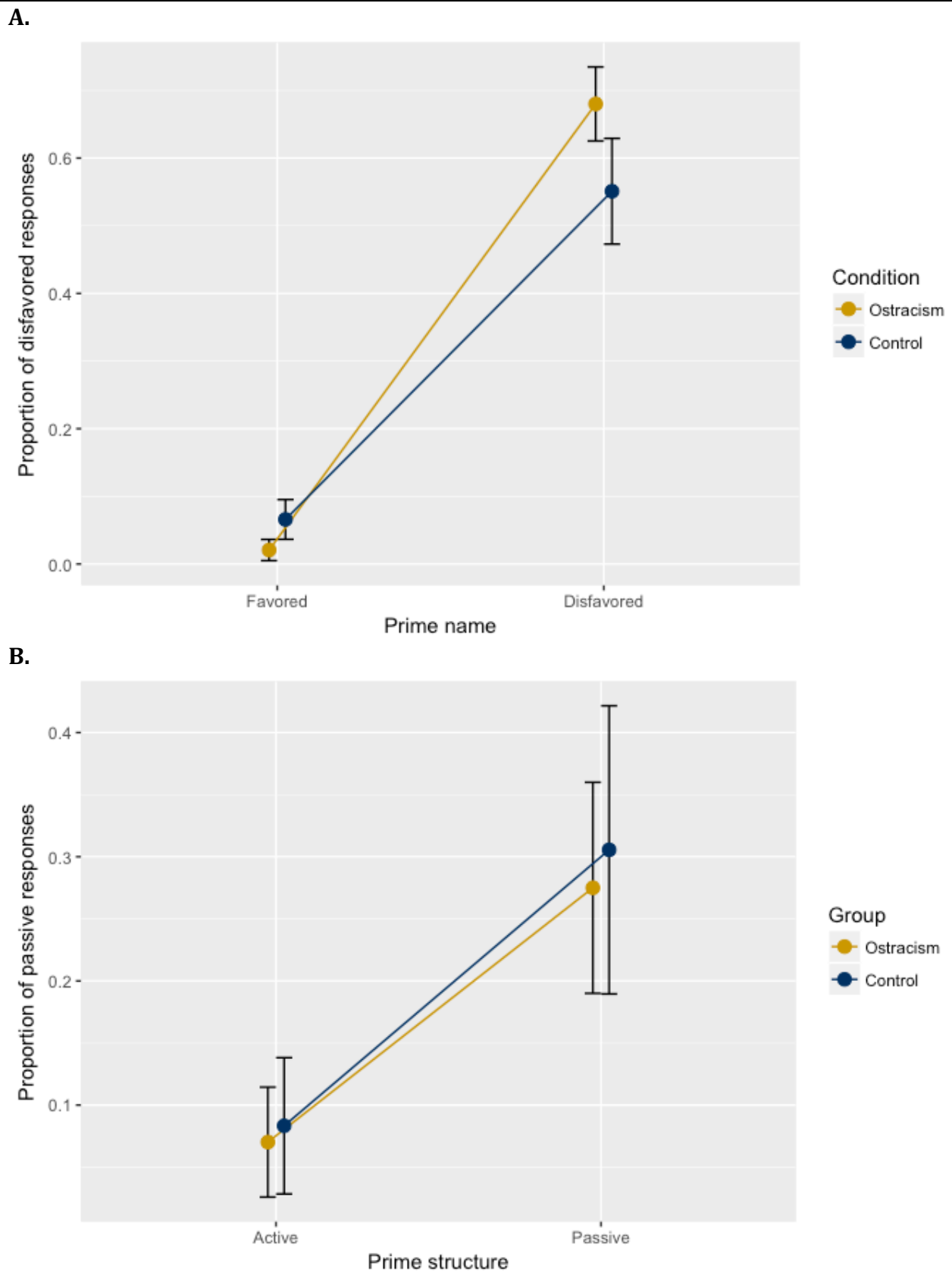


Figure 3. Line graphs of prime\*condition interactions. **A.** Predicts lexical alignment. **B.** Predicts syntactic alignment.